Distribution and Abundance of Pacific Herring off the West Coast of Vancouver Island, September 26-October 30, 1984

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DISTRIBUTION AND ABUNDANCE OF PACIFIC HERRING OFF THE WEST COAST OF VANCOUVER ISLAND, SEPTEMBER 26-OCTOBER 30, 1984

by

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ABSTRACT

Rosenfeld, L., V. Haist, and D. Chalmers. 1987. Distribution and abundance of Pacific herring off the west coast of Vancouver Island, September 26-October 30, 1984. Can. MS Rep. Fish. Aquat. Sci. 1924: 23 p.

A midwater trawl survey was conducted during September 26-October 30, 1984 to determine the distribution and abundance of herring off the southwest coast of Vancouver Island. Twenty-one tows were made to estimate species composition. Sufficient herring for representative samples were found in 13 tows. Age compositions, average length and weight, and Hjort maturities are summarized. Catch rates could not be used as an index of abundance.

Key words: Clupea harengus pallasi, pacific herring, offshore distribution

RESUME

Rosenfeld, L., V. Haist, and D. Chalmers. 1987. Distribution and abundance of Pacific herring off the west coast of Vancouver Island, September 26-October 30, 1984. Can. MS Rep. Fish. Aquat. Sci. 1924: 23 p.

Du 26 september au 30 octobre 1984, on a effectué un relevé au chalut mésopélagique afin de déterminer la répartition et l'abondance du hareng au large de la côte sud-ouest de l'île Vancouver. À cette fin, on a réalisé 21 traits afin de déterminer la composition spécifique. Une quantité suffisante de hareng a été capturée dans 13 traits pour obtenir des échantillons représentatifs. On présente un résumé de la composition selon l'âge, de la longueur et du poids moyens et des indices de maturité de Hjort. Les taux de capture n'ont pu être utilisés comme indice de l'abondance.

Mots-clés: Clupea harengus pallasi, hareng du Pacifique, répartition hauturière

INTRODUCTION

In September and October, 1984, an offshore cruise was conducted off southwest Vancouver Island to assess the distribution, abundance, and relative cohort strength of Pacific herring. This cruise was initiated because of concern about the decline of herring stocks on the south coast of British Columbia. Herring stocks on the west coast of Vancouver Island had been delining steadily over the past five years and this area was closed to commercial herring roe fisheries in 1985. The 1984 spawning abundance in the Strait of Georgia was also substantially below average (Haist et al. 1985). An unusually high proportion of mature two year old fish was observed in many areas of the Strait of Georgia and on the west coast of Vancouver Island in 1984. For the 1985 stock forecasts and recommended catch levels it was assumed that the high proportion of mature two year-old herring was indicative of a declining population, rather than a large year-class (Haist et al. 1985). The fall offshore cruise was intended to substantiate the decline in stock abundance and the estimates of cohort strength used in stock forecasts.

The distribution and abundance of herring on the west coast of Vancouver Island have been investigated by offshore cruises since 1969. Initially these cruises used only conventional echo sounder equipment which provides a rough qualitative estimate of abundance. Four cruises conducted from 1979 to 1981 used a digital echo integrator in conjunction with sounder equipment to obtain absolute estimates of biomass. The echo integration equipment and personnel familiar with its use were not available for the 1984 fall cruise, so a swept-volume midwater trawl survey technique was attempted.

METHODS

This cruise was conducted between September 26 and October 30, 1984, using the 31 m charter trawler, the M/V ROYAL CANADIAN. Because of time lost to travel and poor weather only 24 days were effectively available for the survey. The survey was comprised of three tasks. The first was sounding pre-determined track-lines to document the location and relative abundance of fish concentrations. The second task was fishing observed concentrations to determine species composition, obtain herring samples to determine biological characteristics, and to determine if catch rates could be applied to the relative abundance observations to estimate absolute abundance. The final task was intensive echo-sounding surveys of major herring concentrations to see if methods developed and applied to estimate herring biomass inshore were applicable to offshore concentrations.

HYDROACOUSTIC SURVEY TRACK-LINES

The track-line grid (Fig. 1) was designed to cover the areas of major herring concentrations determined from previous offshore cruises (e.g., McCarter et al. 1982). Track-lines followed Loran C lines and were spaced either .65 or 1.30 nautical miles apart depending on the expected herring concentrations in the area. Echo sounding was carried out following the grid of the transect lines and Loran C was used to determine the vessel's position along the track-lines. Some track-lines were omitted due to time constraints and poor weather. The swept-volume method for estimating biomass involves echo-sounder surveys to locate and categorize the volume and intensity of fish schools, and mid-water trawling to measure density of fish schools (Thompson et al. 1982). When a school of fish was located, the loran coordinates were recorded, as well as time, depth of school, bottom depth, and intensity as indicated by the colour of the echo on the sounder.

NETS AND ELECTRONIC EQUIPMENT

All tows were made with a #7 Polish rope trawl net. The depth of the net was determined and controlled using a wired netsounder system. A Wesmar model 265 colour sonar was used at a 26 degree tilt and 800 foot range to increase the area on either side of the vessel scanned electronically for fish schools. In addition to an Ekolite herring model sounder, the vessel was equipped with a Skipper C8-108 sounder which operated at 38khz and a JRC Model NJA 311 wet paper sounder operated at a gain of 2.5.

CATCH AND SAMPLING

Weather permitting, midwater trawl tows were made whenever concentrations of fish were observed on the sounder. The location of all tows are shown in Figure 2. Catches from most tows were brought aboard, sorted by species into tubs and weighed. If catches were too large to bring aboard, 1 or 2 splits were taken aboard for samples and the rest of the catch was released. Catch weight was estimated by the captain of the vessel.

Herring were sampled for age, maturity and length composition. From each catch a random sample of 200 to 300 fish was taken. Samples were frozen for later examination in the laboratory. From each of these fish a scale was taken and standard length to the nearest millimeter, weight, sex, and degree of maturity was recorded. Herring maturity stages are classified according to the descriptions in Table 1.

INTENSIVE ECHO-SOUNDING SURVEY

Armstrong has developed an intensive echo sounding survey method for inshore use that is designed to provide fishery managers with consistent biomass abundance estimates.[1] These surveys are generally conducted nearshore, and at night, when herring form an even layer called a skimmer. This schooling formation is best for producing reliable tonnage estimates because the fish are evenly distributed at a relatively consistent depth and density. A zig-zag survey pattern is used to determine the surface area of the herring school, and intensity and depth are recorded frequently. Intensity is determined from the darkness of the tracing on the echo sounder paper and is thus somewhat subjective. Intensities are converted to tonnes as specified in Table 2. These conversions have been determined by fishing herring skimmers at various intensity levels.

This intensive echo sounding survey was attempted on Swiftsure Bank and the Finger Bank area for estimating herring biomass.

RESULTS AND DISCUSSION

The grid line design is shown in Figure 1. Completed lines are solid; lines not sounded are indicated by dashes. As shown in Table 3, a total distance of 840.6 nautical miles was sounded at an average speed of 6.9 knots. The relative amount of fish present was estimated by measuring the length and depth of schools on the echo-sounder paper. Length and depth measurements were converted to meters, and the area of each school calculated in square meters. The number of square metres per track-line series formed a relative index of fish density in each area. The loran coordinates of the fish concentrations were recorded, and the schools were subsequently plotted using different symbols to indicate area in square meters (Fig. 3). Track-line series 3 (south of the Finger Bank area) had the highest school density with 661 square meters occuring per mile. As seen in Figure 3, the Southwest Corner and the Southeast Corner areas also had large numbers of fish schools. Generally these schools were found along the 100 meter contour.

Twenty-one midwater tows were made (Fig. 2) to estimate species composition and to provide basic biological information on the herring catches. Species composition and fishing information are summarized in

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[1]Bob Armstrong, Field Services Branch, South Coast Division. Herring/Sounder/Sonar Course. Unpublished.

Table 4. Catches of herring varied from 1.4 to 13600 kg in tows ranging from 8 to 45 min.

Herring were the dominant species in 12 of 20 successful tows. However, the species compositions observed in the tows are probably not representative of the survey area, as tows were made primarily on schools which showed characteristic herring traces on the echo sounder paper. After the first two tows were made on Swiftsure Bank it was clear that catch rates could not be used to estimate total abundance. Herring are quite capable of avoiding the trawl net, and during the first tow traces which were assumed to be herring, were seen on the net sounder paper moving both above and below the net opening. Only 40 kg of herring representing less than 2% of the total catch were caught. During the second tow no traces were seen above or below the net, and herring comprised 67% of the species caught by weight. It was felt that the second sample was more representative of the schools we had attempted to catch.

Sufficient herring for representative samples were found in 13 tows. Age compositions for herring are calculated by location and tow in Table 5, with average weight and length per tow included in Table 6 and Table 7, respectively. Three year old herring were predominant in five of the thirteen samples. Age two herring comprised 92% of the herring caught in the Southwest Corner area, as well as being dominant in the Big Bank tow and one of the five Southeast Corner tows. The Hjort maturity scale is described in Table 1, and the resulting maturity classifications by tow are listed in Table 8. Most herring sampled were at maturity stages 2 or 3 (starting or developing).

The intensive hydroacoustic survey technique to estimate abundance was attempted on Swiftsure Bank and in the Finger Bank area. It did not prove to be a viable method for estimating tonnage. When the herring moved up off the bottom at dusk they very quickly dispersed to such an extent that the sounder was unable to detect them. This may have been due to the fact that there were very few herring in the area, or that there were no shoreline boundaries present to limit the dispersal of the fish. On all occasions when the survey was conducted, only one or two passes over the fish could be carried out before they disappeared from the sounder recording.

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REFERENCES

Haist, V., M. Stocker, and J. F. Schweigert. 1985. Stock assessments for British Columbia herring in 1984 and forecasts of the potential catch in 1985. Can. Tech. Rep. Fish. Aquat. Sci. 1365: 53 p.

McCarter, P. B., L. W. Barner, and F. H. C. Taylor. 1982. Midwater trawl tows and catches made on C.G.S. G.B. REED cruise GBR81-3, M/V HOWE BAY cruise HB81-1, and M/V MARWOOD cruise MW81-1 off the southwest coast of Vancouver Island, March 9-27, 1981. Can. Data Rep. Fish. Aquat. Sci. 352: 113 p.

Thompson, J. M. and G. A. McFarlane. 1982. Distribution and abundance of Pacific hake and walleye pollock in the Strait of Georgia, March 24-May 2, 1981. Can. MS Rep. Fish. Aquat. Sci. 1661: 79 p.

Table 1. Maturity stages for Pacific herring. The descriptions of each stage are adapted from criteria developed for Atlantic herring (Bowers and Holliday 1961; Parrish and Saville 1965) and modified to suit the unique characteristics of Pacific herring which are exclusively winter-spring spawners.

Stage	State of maturity	Gonad appearance	Description	Timing
I.	Undeveloped	Thread-shaped	Virgin herring with small gonads, less than 2 mm broad. Accurate macroscopic determination of sex usually not possible.	Year-round for young herring, usually less than 150 mm in standard length.
II.	Starting	Ribbon-shaped	Gonads increased in breadth to 3-5 mm. Sex determination possible. Testes reddish-gray colored and knife-shaped; ovaries reddish-wine colored and rounder. (The gonads of virgins and some repeat spawners cannot be differentiated macroscopically.)	Late spring and early summer.
III.	Developing	Tube-like	Gonads thickened, increased in breadth (5-15 mm) and elongated, but not extending full length of body cavity. Ovaries red to reddish-orange with granular appearance; testes reddish-gray with smooth texture.	Late summer and early fall.
IV.	Maturing	Prominent	Gonads extend full length of body cavity. Ovaries reddish-orange to yellow; eggs distinguishable, opaque, variable in size and separable. Testes mostly grey and will ooze milt if sliced with a knife. Blood vessels clearly visible in the ovary and testes walls.	Late fall and early winter (slightly earlier in males than females).

Table 1 (cont.)

Stage	State of maturity	Gonad appearance	Description	Timing
V.	Mature	Bulging	No blood vessels visible in gonad walls. Ovaries gold-yellow; eggs mostly transparent and uniform in size. Eggs can be exuded from the ovary under pressure and are adhesive on contact. Testes milk-white; milt will flow under pressure.	Early winter for males, late winter for females.
VI.	Ripe	Running	Eggs transparent. Eggs and milt flow easily without external pressure.	A few days prior to spawning (usually in late winter or early spring).
VII.	Spent	Baggy	Gonads slack. Ovaries may contain a few residual eggs. Testes limp and bloodshot.	Early spring for the first few weeks following spawning.
VIII.	Recovering	Compressed	Gonads wine-colored and usually longer and thicker than in Stage II. Blood vessels prominent. (This stage passes into Stage III, but may resemble Stage II in the process.)	Late spring and early summer.

Table 2. Tons (and tonnes) of herring per square nautical mile as estimated by echo sounder surveys.[a]

Light intensity skimmers			Light to medium skimmers			Medium intensity skimmers		
1 fathoms deep	Tons	(Tonnes)	1 fathoms deep	Tons	(Tonnes)	1 fathoms deep	Tons	(Tonnes)
2 " "	600	(500)	2 " "	900	(800)	1 " "	1,200	(1,100)
3 " "	1,200	(1,100)	3 " "	1,800	(1,600)	2 " "	2,400	(2,200)
4 " "	1,800	(1,600)	4 " "	2,700	(2,400)	3 " "	3,600	(3,300)
5 " "	2,400	(2,200)	5 " "	3,600	(3,300)	4 " "	4,800	(4,400)
6 " "	3,000	(2,700)	6 " "	4,500	(4,100)	5 " "	6,000	(5,400)
7 " "	3,600	(3,300)	7 " "	5,400	(4,900)	6 " "	7,200	(6,500)
8 " "	4,200	(3,800)	8 " "	6,300	(5,700)	7 " "	8,400	(7,600)
9 " "	4,800	(4,400)	9 " "	7,200	(6,500)	8 " "	9,600	(8,700)
10 " "	5,400	(4,900)	10 " "	8,100	(7,300)	9 " "	10,800	(9,800)
11 " "	6,000	(5,400)	11 " "	9,000	(8,200)	10 " "	12,000	(10,900)
12 " "	6,600	(6,000)	12 " "	9,900	(9,000)	11 " "	13,200	(12,000)
13 " "	7,200	(6,500)	13 " "	10,800	(9,800)	12 " "	14,400	(13,100)
14 " "	7,800	(7,100)	14 " "	11,700	(10,600)	13 " "	15,600	(14,200)
15 " "	8,400	(7,600)	15 " "	12,600	(11,400)	14 " "	16,800	(15,200)
16 " "	9,000	(8,200)	16 " "	13,500	(12,200)	15 " "	18,000	(16,300)
17 " "	9,600	(8,700)	17 " "	14,400	(13,100)	16 " "	19,200	(17,400)
18 " "	10,200	(9,300)	18 " "	15,300	(13,900)	17 " "	20,400	(18,500)
19 " "	10,800	(9,800)	19 " "	16,200	(14,700)	18 " "	21,600	(19,600)
20 " "	11,400	(10,300)	20 " "	17,100	(15,500)	19 " "	22,800	(20,700)
21 " "	12,000	(10,900)	21 " "	18,000	(16,300)	20 " "	24,000	(21,800)
22 " "	12,600	(11,400)	22 " "	18,900	(17,100)	21 " "	25,200	(22,900)
23 " "	13,200	(12,000)	23 " "	19,800	(18,000)	22 " "	26,400	(24,000)
24 " "	13,800	(12,500)	24 " "	20,700	(18,800)	23 " "	27,600	(25,000)
25 " "	14,400	(13,100)	15 " "	21,600	(19,600)	24 " "	28,800	(26,100)
	15,000	(13,600)		22,500	(20,400)	25 " "	30,000	(27,200)

[a]Bob Armstrong, Field Services Branch, South Coast Division. Herring/Sounder/Sonar Course. Unpublished.

Table 3. Track line characteristics.

Track line series	Location	Length travelled (miles)	Duration (hours)	Average speed (knots)	Number of schools recorded	Average school size (sq. m.)	School density (sq. m./mile)
1	Swiftsure	57.9	7.7	8.0	34	634.0	372.3
2	Prairie Ground	130.0	17.8	7.3	51	406.1	159.3
3	South of Finger Bank	54.3	7.7	7.1	60	598.4	661.2
4	Outside Edge Big Bank	74.4	11.0	7.0	12	1303.9	210.3
5	Southeast Corner	289.5	43.7	6.6	148	827.0	422.8
6	Southwest Corner	162.8	25.1	6.4	110	632.6	427.4
7	Cabbage Patch	30.3	4.5	6.7	6	549.1	108.7
8	Firing Range	41.4	6.4	6.4	22	468.9	249.2
	TOTAL	840.6	123.9		443		

Table 4. Fishing log for the M/V ROYAL CANADIAN, Sept. 26-Oct. 30, 1984.

Tow number	1	2	3	4	5
Date	Sept.28	Sept.28	Oct.1	Oct.1	Oct.2
Avg. net depth (M)	82.2	91.4	131.6	78.6	82.3
Avg. net opening (M)	14.6	14.6	14.6	13.7	14.6
Avg. bottom (M)	109.7	109.7	151.8	95.0	98.7
Starting time (PDT)	0830	1043	1458	1743	1416
Duration (Min)	35	31	8	17	34
Start latitude	48°30.4	48°33.3	48°27.2	48°31.5	48°27.6
Start longitude	124°53.4	124°48.1	125°27.7	125°33.2	125°34.1
End latitude	48°30.7	48°32.8	48°27.1	48°31.4	48°27.2
End longitude	124°52.0	124°51.0	125°28.1	125°34.9	125°36.7
Hedline Temp (Deg C)	9.	NA	7.7	NA	NA
Species Catch (KG)					
Herring	40.	7300*		14.	13600*
Anchovy					
Blackcod	5.	Tr			Tr
Dogfish	2300*	2900*			
Eulachon					
Hake			1800*		
Lingcod					
Pacific cod					
Rockfish	1.5	700*	Tr		
Salmon	10.	4*		10.8	
Squid					
Walleye pollock					
Misc. species			Tr[a]		
Total catch	2356.5*	10904*	1800*	24.8	13600*
% hering by weight	1.7	66.9	0	56.4	100.

*Indicates figures are estimated. Total catch was not weighed.
[a]Shad

Table 4 (cont.) Fishing log for the M/V ROYAL CANADIAN, Sept. 26 - Oct. 30, 1984.

Tow number	6	7	8	9	10
Date	Oct.6	Oct.6	Oct.15	Oct.17	Oct.18
Avg. net depth (M)	65.8	82.3	76.8	47.5	25.6
Avg. net opening (M)	14.6	14.6	14.6	14.6	14.6
Avg. bottom (M)	95.	98.7	95.	65.8	62.1
Starting time (PDT)	0833	1033	1243	0840	0640
Duration (Min)	42	30	19	38	40
Start latitude	48°53.8	48°56.7	48°45.9	48°38.5	48°39.1
Start longitude	125°13.5	125°10.6	125°46.3	124°54.8	125°03.0
End latitude	48°52.5	48°55.6	48°44.9	48°37.9	48°40.7
End longitude	125°14.8	125°12.0	125°47.6	124°57.0	125°05.3
Headline Temp (Deg C)	10.7	8.	10.	12.	13.
Species Catch (KG)					
Herring	2.7		40.	1.4	2.3
Anchovy				Tr	Tr
Blackcod				1.8	
Dogfish		4.	1.	3.4	1.7
Eulachon				Tr	
Hake		2300*		1.	
Lingcod		45.			
Pacific cod				5.	
Rockfish			1.	2.3	1.3
Salmon	3.		24.5		19.
Squid	Tr		Tr	Tr	Tr
Walleye pollock	1.	Tr		Tr	
Misc. species				Tr[a]	Tr[a]
Total catch	6.7	2349*	66.5	14.9	24.3
% herring by weight	40.3	0.	60.2	9.4	9.5

*Indicates figures are estimated. Total catch was not weighed.
[a]Jellyfish.

Table 4 (cont.) Fishing log for the M/V ROYAL CANADIAN, Sept. 26 - Oct. 30, 1984.

Tow number	11	12	13	14	15
Date	Oct.20	Oct.20	Oct.20	Oct.22	Oct.23
Avg. net depth (M)	31.1	NA	76.8	65.8	54.9
Avg. net opening (M)	14.6	15.5	13.7	14.6	14.6
Avg. bottom (M)	62.1	87.8	96.9	82.3	71.3
Starting time (PDT)	1100	1310	1715	1125	1120
Duration (Min)	23	32	25	42	35
Start latitude	48°32.5	48°31.2	48°29.1	48°32.2	48°32.5
Start longitude	125°36.9	125°37.6	125°36.5	125°34.2	125°36.8
End latitude	48°33.4	48°31.2	48°28.4	48°32.2	48°34.5
End longitude	125°38.5	125°35.7	125°38.0	125°37.2	125°34.5
Headline Temp (Deg C)	10.5	11.	10.	9.5	11.
Species Catch (KG)					
Herring	1400*	900*	1600*	2700*	165.
Anchovy					
Blackcod		1.3		1.8	
Dogfish		1.8	132.	15.8	
Eulachon					
Hake					
Lingcod					
Pacific cod					
Rockfish			10.	11.3	
Salmon				40.	
Squid					
Walleye pollock					
Misc. species					
Total catch	1400*	903.1*	1742*	2768.9*	165.
% hering by weight	100.	100.	91.8	97.5	100.

*Indicates figures are estimated. Total catch was not weighed.
[a]Jellyfish.

Table 4 (cont.) Fishing log for the M/V ROYAL CANADIAN, Sept. 26 - Oct. 30, 1984.

Tow number	16	17	18	19	20
Date	Oct.24	Oct.29	Oct.29	Oct.29	Oct.29
Avg. net depth (M)	64.	75.	NA	NA	27.4
Avg. net opening (M)	14.6	14.6	NA	NA	18.3
Avg. bottom (M)	84.1	91.4	118.9	128.	95.
Starting time (PDT)	0900	1330	1450	1540	1740
Duration (Min)	45	15	15	8	32
Start latitude	48°49.6	48°31.2	48°26.5	48°26.7	48°29.5
Start longitude	125°25.8	125°36.5	125°34.9	125°32.6	125°29.2
End latitude	48°49.2	48°40.4	48°26.5	48°26.7	48°30.6
End longitude	125°27.4	125°36.5	125°33.8	125°34.2	125°28.2
Headline Temp (Deg C)	11.	10.5	12.	NA	9.5
Species Catch (KG)					
Herring		4500*	4.5		18.
Anchovy	Tr				
Blackcod			1.4		
Dogfish			136.		
Eulachon			Tr		
Hake					
Lingcod					
Pacific cod					
Rockfish	2720*	Tr			
Salmon	7.3				
Squid					
Walleye pollock					
Misc. species			Tr[a]		
Total catch	2727.3*	4500*	141.9		18.
% hering by weight	0.	100.	3.2		100.

*Indicates figures are estimated. Total catch was not weighed.
[a]Rockcrab, sole, sea urchins.

Table 4 (cont.) Fishing log for the M/V ROYAL CANADIAN, Sept. 26 - Oct. 30, 1984.

Tow number	21
Date	Oct.15
Avg. net depth (M)	51.2
Avg. net opening (M)	14.6
Avg. bottom (M)	71.3
Starting time (PDT)	1005
Duration (Min)	33
Start latitude	48°44.9
Start longitude	125°48.2
End latitude	48°45.6
End longitude	125°45.8
Headline Temp (Deg C)	11.

Species Catch (KG)	
Herring	1400*
Anchovy	
Blackcod	
Dogfish	
Eulachon	
Hake	
Lingcod	
Pacific cod	
Rockfish	
Salmon	23.
Squid	
Walleye pollock	
Misc. species	
Total catch	1423*
% hering by weight	98.3

*Indicates figures are estimated. Total catch was not weighed.

Table 5. Herring percentage age composition by location and tow, southwest coast of Vancouver Island, September 26 - October 30, 1984.

Location	Tow no.	Age								
		2	3	4	5	6	7	8	9	10+
Swiftsure	1	-	25.0	38.9	19.4	16.7	-	-	-	-
	2	2.3	25.3	24.1	27.6	13.8	1.1	3.4	2.3	-
	Average	1.2	25.2	31.5	22.5	15.3	0.6	1.7	1.2	-
Finger Bank	5	-	6.4	44.7	14.9	16.0	9.6	5.3	2.1	1.1
	13	13.7	52.1	23.3	5.5	2.7	-	2.7	-	-
	20	29.9	48.1	15.6	1.3	2.6	2.6	-	-	-
	Average	14.6	35.5	27.9	7.2	7.1	4.1	2.7	0.7	0.4
Southeast corner	4	5.7	67.1	18.6	4.3	4.3	-	-	-	-
	11	30.8	57.1	11.0	-	1.1	-	-	-	-
	12	29.6	49.4	13.6	2.5	1.2	3.7	-	-	-
	14	1.1	32.2	33.3	12.6	6.9	12.6	1.1	-	-
	17	73.6	25.3	1.1	-	-	-	-	-	-
	Average	28.2	46.2	15.5	3.9	2.7	3.3	0.2	-	-
Southwest corner	8	90.2	7.3	2.4	-	-	-	-	-	-
	21	94.6	3.6	-	-	-	-	-	-	-
	Average	92.4	5.5	1.2	-	-	-	-	-	-
Big Bank	15	60.8	32.4	4.1	-	-	1.4	-	-	1.4

Table 6. Average weight (grams) at age, numbers sampled and aged, for herring collected in tows made by the M/V ROYAL CANADIAN.

Tow number	Number of fish	Fish aged	Avg. weight at age								
			2	3	4	5	6	7	8	9	10+
1	100	36		103	143	157	176				
2	100	87	55	104	131	157	184	236	211	208	
4	95	70	67	89	121	135	137				
5	100	94		122	153	180	204	205	225	232	208
8	100	41	47	105	123						
11	100	91	65	97	108		165				
12	100	81	67	102	135	147	174	171			
13	100	73	61	103	128	165	203		190		
14	100	87		106	148	162	190	195	225		
15	100	74	57	94	144			214			232
17	100	91	58	93	119						
20	100	77	67	105	136	160	184	180			
21	100	56	48	113				234			

Table 7. Average length (millimeters) at age for herring collected in tows made by the M/V ROYAL CANADIAN.

Tow number	Avg. length at age								
	2	3	4	5	6	7	8	9	10+
1		185	209	208	207				
2	152	187	198	210	220	251	232	229	
4	160	178	196	205	204				
5		190	206	214	227	224	232	235	223
8	147	190	206						
11	160	180	189		218				
12	162	182	199	215	226	217			
13	159	183	200	214	232		226		
14		186	206	212	224	223	227		
15	153	180	207			225			239
17	158	181	192						
20	162	184	198	218	224	223			
21	145	186				232			

Table 8. Maturity stages for herring collected in tows made by the M/V ROYAL CANADIAN.

		% at Hjort maturity stage				
		1	2	3	4	Unknown
Tow 1	Age 2	-	-	-	-	-
	Age 3+	-	14	83	3	-
Tow 2	Age 2	-	2	-	-	-
	Age 3+	-	39	59	-	-
Tow 4	Age 2	-	3	3	-	-
	Age 3+	-	24	61	9	-
Tow 5	Age 2	-	-	-	-	-
	Age 3+	-	20	80	-	-
Tow 8	Age 2	-	5	85	-	-
	Age 3+	-	-	10	-	-
Tow 11	Age 2	-	26	-	-	4
	Age 3+	-	55	15	-	-
Tow 12	Age 2	-	14	15	1	-
	Age 3+	-	5	61	4	-
Tow 13	Age 2	-	8	4	1	-
	Age 3+	-	5	62	10	-
Tow 14	Age 2	-	1	-	-	-
	Age 3+	-	42	44	13	-
Tow 15	Age 2	-	50	5	-	5
	Age 3+	-	5	32	3	-
Tow 17	Age 2	-	44	30	-	-
	Age 3+	-	-	26	-	-
Tow 20	Age 2	-	29	-	-	1
	Age 3+	-	23	46	1	-
Tow 21	Age 2	4	76	14	-	-
	Age 3+	-	4	2	-	-

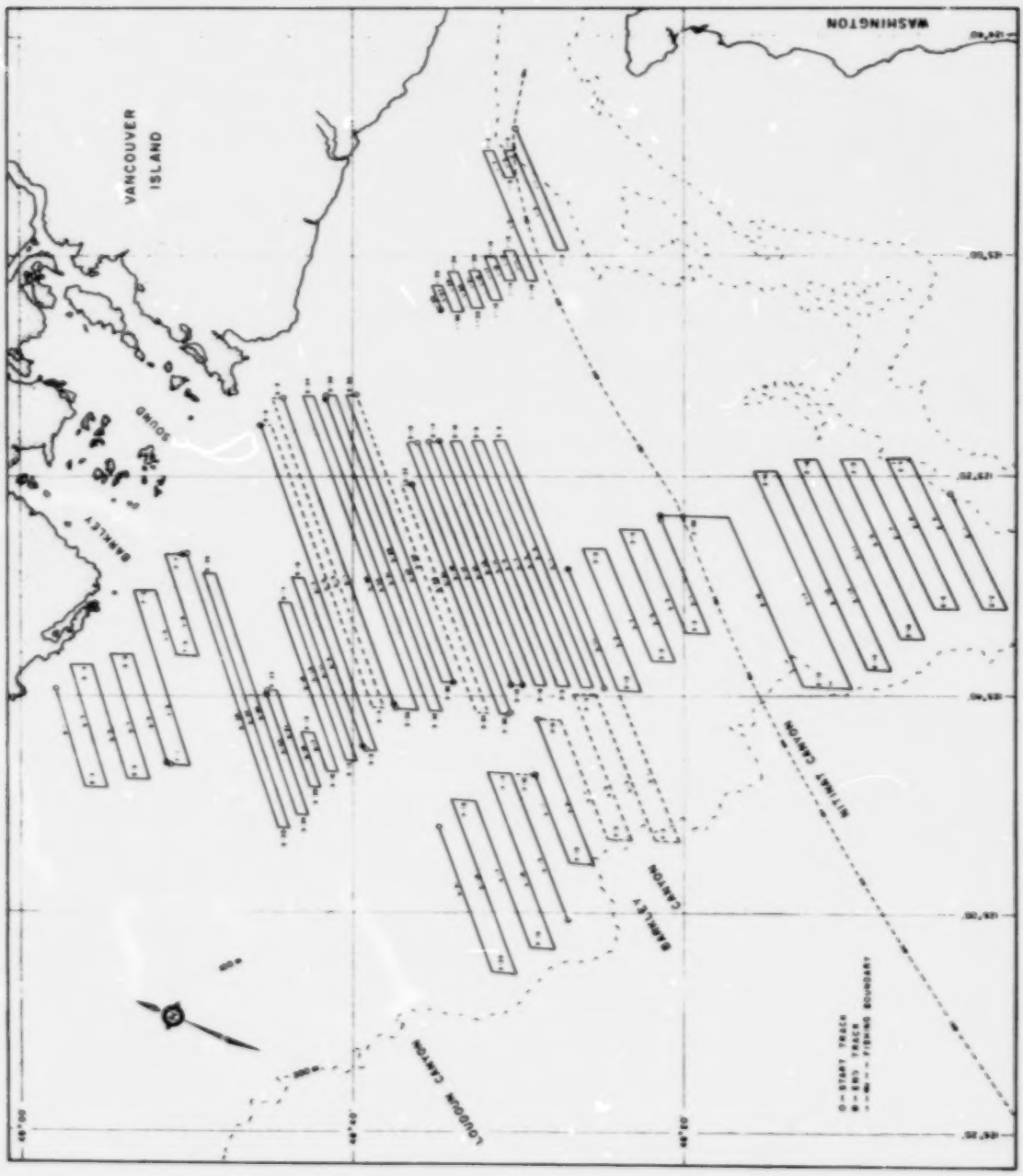

Fig. 1. Hydroacoustic survey track-lines of the M/V ROYAL CANADIAN off the southwest coast of Vancouver Island, Sept. 26-Oct. 30, 1984.

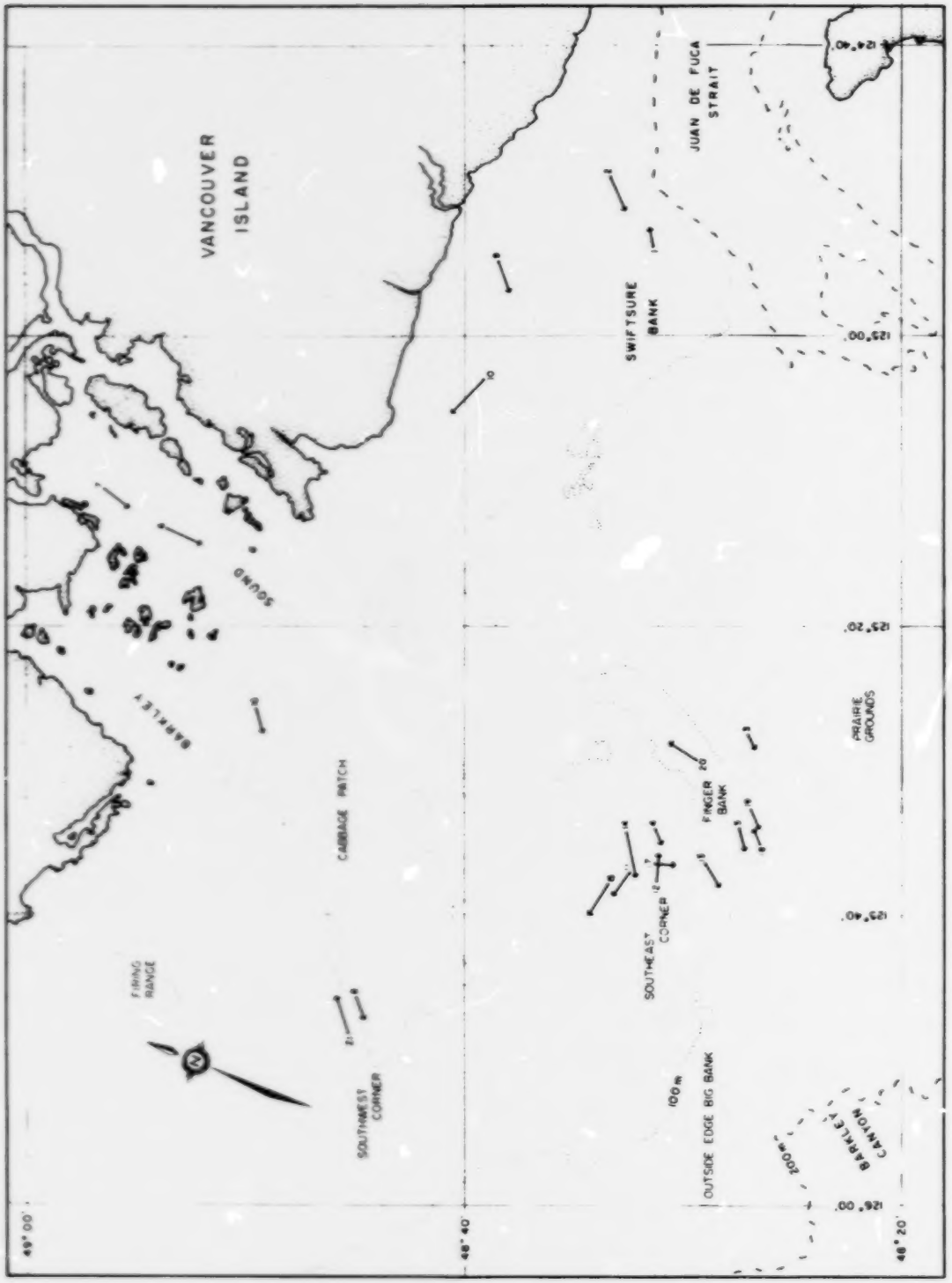

Fig. 2. Locations of midwater trawl tows, Sept. 26-Oct. 30, 1984.

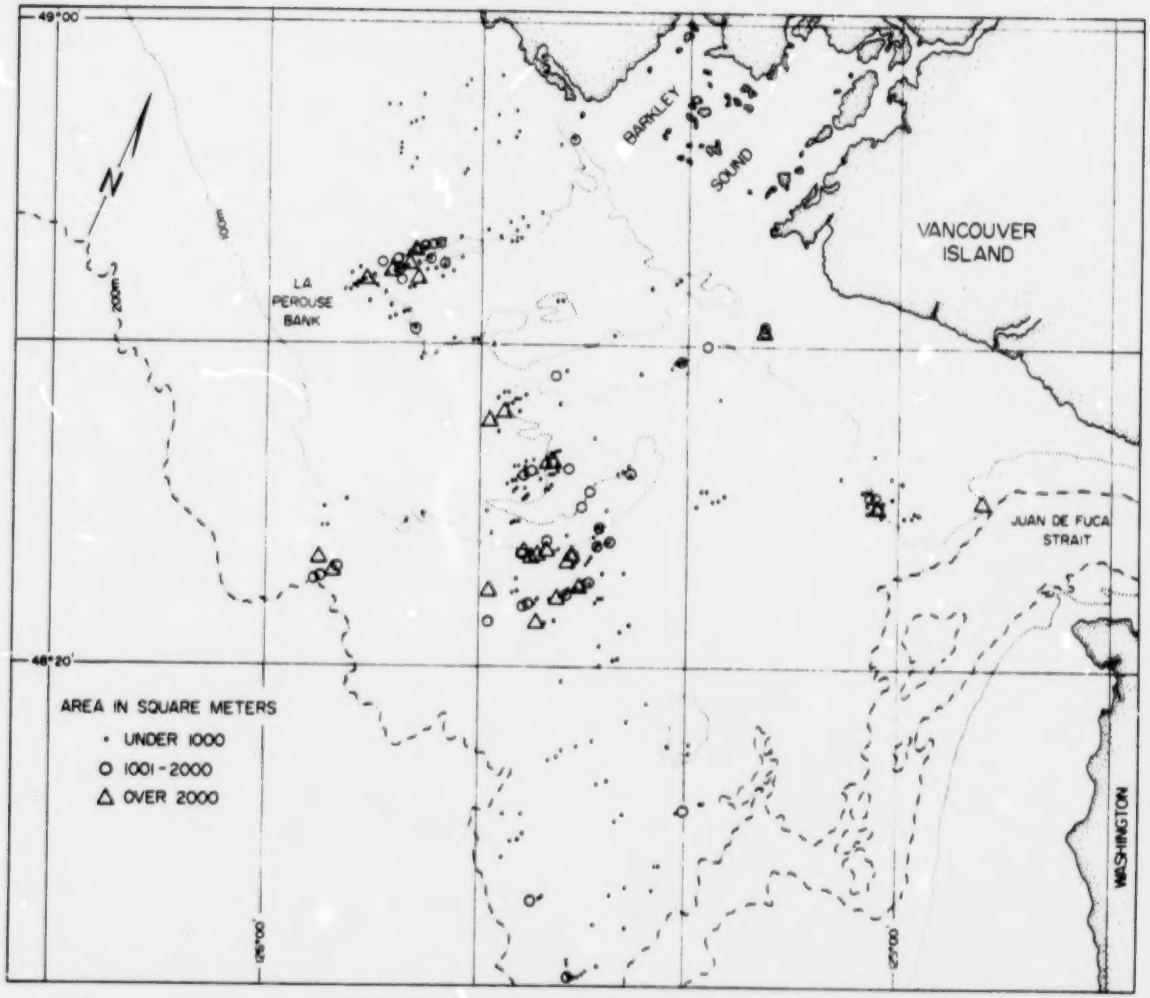

Fig. 3. Location and size of fish concentrations, Sept. 26-Oct. 30, 1984.